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Please find below and/or attached an Office communication concerning this application or proceeding.

The time period for reply, if any, is set in the attached communication.

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# Office Action Summary

Application No.

10/680,839

Applicant(s)

MARAVIC ET AL.

Examiner

James M. Perez

Art Unit

2611

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

## Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) OR THIRTY (30) DAYS, WHICHEVER IS LONGER, FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133). Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

## Status

- 1) ☒ Responsive to communication(s) filed on 07 October 2003.
- 2a) ☐ This action is **FINAL**. 2b) ☒ This action is non-final.
- 3) ☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

## Disposition of Claims

- 4) ☒ Claim(s) 1-33 is/are pending in the application.
- 4a) Of the above claim(s) \_\_\_\_\_ is/are withdrawn from consideration.
- 5) ☐ Claim(s) \_\_\_\_\_ is/are allowed.
- 6) ☒ Claim(s) 1-33 is/are rejected.
- 7) ☐ Claim(s) \_\_\_\_\_ is/are objected to.
- 8) ☐ Claim(s) \_\_\_\_\_ are subject to restriction and/or election requirement.

## Application Papers

- 9) ☐ The specification is objected to by the Examiner.
- 10) ☒ The drawing(s) filed on 07 October 2003 is/are: a) ☒ accepted or b) ☐ objected to by the Examiner.  
Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).  
Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).
- 11) ☐ The oath or declaration is objected to by the Examiner. Note the attached Office Action or form PTO-152.

## Priority under 35 U.S.C. § 119

- 12) ☒ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).
- a) ☒ All b) ☐ Some \* c) ☐ None of:
1. ☒ Certified copies of the priority documents have been received.
  2. ☐ Certified copies of the priority documents have been received in Application No. \_\_\_\_\_.
  3. ☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

\* See the attached detailed Office action for a list of the certified copies not received.

## Attachment(s)

- 1) ☒ Notice of References Cited (PTO-892)
- 2) ☐ Notice of Draftsperson's Patent Drawing Review (PTO-948)
- 3) ☐ Information Disclosure Statement(s) (PTO/SB/08)  
Paper No(s)/Mail Date \_\_\_\_\_
- 4) ☐ Interview Summary (PTO-413)  
Paper No(s)/Mail Date. \_\_\_\_\_
- 5) ☐ Notice of Informal Patent Application
- 6) ☐ Other: \_\_\_\_\_

***Detailed Action***

***Claim Objection***

Claim 33 is objected to as being indefinite for failing to particularly point out and distinctly claim the subject matter which applicant regards as the invention. Note that claim 33 indirectly depends on Claim 29. Claim 29 recites, "a receiver for decoding a signal sent over a bandwidth-expanding communication system" (claim 29, lines 1-3). Claim 33 states "encoder... for encoding a signal to be sent over said bandwidth-expanding channel...." (Claim 33, lines 2-4). These two claims describe the functions of both a transmitter and receiver even though the device is claimed as a receiver. The examiner will interpret the claim limitations of claims 29 through 33 as the functions of a receiver.

***Claim Rejections - 35 USC § 101***

1. 35 U.S.C. 101 reads as follows:

Whoever invents or discovers any new and useful process, machine, manufacture, or composition of matter, or any new and useful improvement thereof, may obtain a patent therefor, subject to the conditions and requirements of this title.

With regards to claim 28, Claim 28 fails to fall within a statutory category of invention. It is directed to the program itself, not a process occurring as a result of executing the program, a machine programmed to operate in accordance with the program nor a manufactures structurally and functionally interconnected with the program in a manner

which enables the program to act as a computer component and realize its functionality. It's clearly not directed to a composition of matter.

***Claim Rejections - 35 USC § 112***

2. The following is a quotation of the first paragraph of 35 U.S.C. 112:

The specification shall contain a written description of the invention, and of the manner and process of making and using it, in such full, clear, concise, and exact terms as to enable any person skilled in the art to which it pertains, or with which it is most nearly connected, to make and use the same and shall set forth the best mode contemplated by the inventor of carrying out his invention.

3. Claim 28 is rejected under 35 U.S.C. 112, first paragraph, as failing to comply with the written description requirement. The claim(s) contains subject matter which was not described in the specification in such a way as to reasonably convey to one skilled in the relevant art that the inventor(s), at the time the application was filed, had possession of the claimed invention. Note that a description or reference to computer program was not contained in the specification, thus the computer program of claim 28 is a new matter situation.

4. The following is a quotation of the second paragraph of 35 U.S.C. 112:

The specification shall conclude with one or more claims particularly pointing out and distinctly claiming the subject matter which the applicant regards as his invention.

5. Claims 31-33 are rejected under 35 U.S.C. 112, second paragraph, as being indefinite for failing to particularly point out and distinctly claim the subject matter which applicant regards as the invention. A receiver receives and decodes the received signal. A transmitter encodes and transmits the encoded signal. The independent of

claim 29 states, "a receiver for decoding a signal sent over a bandwidth-expanding communication system" (claim 29, lines 1-3). Claims 31-33 are dependent on claim 29 and thus must claim the functions of a receiver. Claims 31-33 recited the use of an encoder which is a device used in a transmitter, this does not meet the definition of a receiver since a receiver unit receives and decodes the signal. Therefore claims 31-33 are indefinite, because the receiver unit is claiming a device which is used in a transmitter. The examiner will therefore interpret the encoder to be decoder.

***Claim Rejections - 35 USC § 103***

6. The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

(a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negated by the manner in which the invention was made.

7. Claims 1-8, 16-17, 20-21, and 29 are rejected under 35 U.S.C. 103(a) as being unpatentable over Affes (US 2002/0051433) in view of Unser ("Sampling – 50 Years After Shannon", Proceedings of the IEEE, Vol. 88, No.4: pages 569-587, April 2000.)

With regards to claims 1 and 29, Affes teaches a receiver and method for decoding a signal ( $y(t)$ ) sent over a bandwidth-expanding communication channel (paragraphs 14-23), comprising the step of sampling the received signal ( $y(t)$ ) with a sampling frequency ( $f_s$ ) lower than the sampling frequency given by the Shannon theorem (paragraph 119) for generating a set of sampled values (fig. 9: output of element 18).

Affes does not explicitly teach the sampling rate is greater than the rate of innovation ( $\rho$ ) of said received signal ( $y(t)$ ).

Unser teaches the reconstruction of a consistent signal (which yields the same measurements as the original signal) as long as there are as many measurements (samples) as there are degrees of freedom in the signal (Section V, B). One of ordinary skill in the art at the time of the invention would recognize that since the rate of innovation is defined by the total degrees of freedom of the wanted signal it would be obvious to sample at a greater than or equal to the rate of innovation in order to reconstruct information of the original signal with minimum error. Therefore it would be obvious to one of ordinary skill in the art at the time of the invention to combine the spread spectrum communication sampling method of Affes with the sampling method disclosed by Unser in order to create an improved method and system for sampling and reconstructing the information from the original signal while minimizing errors in the reconstructed information.

With regards to claims 2-3, Affes in view of Unser teaches the limitations of claim 1.

Affes teaches pre-processing of the received signal (fig. 13: element 18).

Affes does explicitly teach the preliminary step of filtering said received signal ( $y(t)$ ) with a filter ( $f$ ).

Unser teaches pre-filter using a low-pass filter (Section II: fig. 2)

Therefore it would be obvious to one of ordinary skill in the art at the time of the invention to combine the spread spectrum communication sampling method of Affes

with the sampling method disclosed by Unser in order to create an improved method and system for sampling and reconstructing the information from the original signal while minimizing errors in the reconstructed information.

With regards to claim 4, Affes in view of Unser teaches the limitations of claim 3.

Affes teaches pre-processing of the received signal (fig. 13: element 18).

Affes does explicitly teach said filter (f) is a sinc filter.

Unser teaches the use of a sinc filter (Section II: fig. 2).

Therefore it would be obvious to one of ordinary skill in the art at the time of the invention to combine the spread spectrum communication sampling method of Affes with the sampling method disclosed by Unser in order to create an improved method and system for sampling and reconstructing the information from the original signal while minimizing errors in the reconstructed information.

With regards to claim 5, Affes in view of Unser teaches the limitations of claim 3.

Affes teaches pre-processing of the received signal (fig. 13: element 18).

Affes does explicitly teach said filter (f) is a Gaussian filter.

Unser teaches the use of B-splines with a Gaussian-like response as the n degree increases (Section III: fig. 3). One of ordinary skill in the art would clearly recognize that Gaussian filters have fast decay which would allow for more accurate signal filtering while minimizing computational burden in a digital system. Therefore it would have been obvious to one of ordinary skill to use a Gaussian filter to pre-filter the

input signal in order to for more accurate signal filtering while minimizing computational burden in a digital system.

With regards to claim 6, Affes in view of Unser teaches the limitations of claim 5.

Affes teaches said bandwidth-expanding communication channel comprises a multipath fading transmission channel (paragraph 116).

With regards to claim 7, Affes in view of Unser teaches the limitations of claim 1.

Affes teaches said bandwidth-expanding communication channel is a CDMA system (paragraph 116-117).

With regards to claim 8, Affes in view of Unser teaches the limitations of claim 7.

Affes teaches sampling of the received signal (paragraph 119).

Affes does not explicitly teach said sampling frequency ( $1/T_s$ ) is lower than the chip rate ( $1/T_c$ ) of said received signal ( $y(t)$ ), but greater than its information rate ( $K/T_b$ ).

Unser teaches the reconstruction of a consistent signal (which yields the same measurements as the original signal) as long as there are as many measurements (samples) as there are degrees of freedom in the signal (Section V, B). Note that the rate of innovation is defined by the total degrees of freedom per unit of time which is carried by the signal.

One of ordinary skill in the art at the time of the invention would clearly recognize that in the case where the degrees of freedom rate of the signal is lower than the chip



rate of the signal, it would be obvious to sample the signal at a rate (frequency) between chip rate and the degrees of freedom rate, since lowering (minimizing) the sampling rate of the received signal lessens the computational burden and complexity of the receiver, and sampling at a rate over the degrees of freedom rate allows for reconstruction of the signal information in a manner which minimizes signal information error.

Therefore it would be obvious to one of ordinary skill in the art at the time of the invention to modify the spread spectrum communication sampling method of Affes with the sampling method based on the degrees of freedom as disclosed by Unser in order to create an improved sampling method which minimize the computational burden and complexity of the receiver, while minimize error in the reconstructed information of the received signal.

With regards to claim 16, Affes in view of Unser teaches the limitations of claim 7.

Affes further teaches the method wherein said sent signal includes a plurality of symbols (figs. 1-2: elements 10, and 13-16) each encoded with said user specific coding sequence (figs. 1-2: elements 10, and 13-16) and transmitted by said users (figs. 1-2: elements 10, and 13-16), said method further comprising the steps of

running a multiuser detection scheme (fig. 16: output of element 18: to receiver for other desired users: note that the decoding process for each user is repeated) using known delays (paragraphs 178-186) and amplitude attenuations (paragraph 114) induced by said communication signal on said sent signal (figs. 1-2, 5, and 9: signal  $X(t)$ ) and using said set of sampled values (fig. 16: output of element 18) and for

estimating the value of the symbol (fig. 16: elements 29: paragraph 21) sent by each said user (fig. 16: output of element 18: to receiver for other desired users: note that the decoding process for each user is repeated).

With regards to claim 17, Affes in view of Onser teaches the limitations of claim 16.

Affes further teaches said multiuser detection scheme (fig. 16: output of element 18: to receiver for other desired users: note that the decoding process for each user is repeated) is a decorrelating detection scheme (paragraph 7).

With regards to claim 20, Affes in view of Unser teaches the limitations of claim 7.

Affes teaches said sent signal includes a plurality of symbols (fig. 2: elements b.sub.n and 13: paragraphs 302-306) each encoded with a user specific coding sequence ( $s_k(t)$ ) (paragraphs 302-306) being chosen, method further comprising the steps of:

sampling the received signal ( $y(t)$ ) with a sampling frequency ( $f_s$ ) lower than the sampling frequency given by the Shannon theorem (paragraph 119) for generating a set of sampled values (fig. 9: output of element 18).

filtering said set of sampled values ( $y(nT_s)$ ) with a bank of matched filters (fig. 16: element group 19: paragraph 119), each filter being matched to said user specific coding sequence (fig. 16: element group 19: despreader) filtered, for estimating the value of the symbol ( $b_k$ ) sent by each said user (fig. 16: elements 19, 42, 29-30).

Affes does not teach that when lowpass filtered, the signal is orthogonal to any

other user's specific coding sequence ( $s_k(t)$ ) used in said communication channel; the sampling rate is greater than the rate of innovation ( $\rho$ ) of said received signal ( $y(t)$ ); and said match filter uses a lowpass filter.

Unser teaches that when lowpass filtered, the signal is orthogonal to any other user's specific coding sequence ( $s_k(t)$ ) used in said communication channel (Section II and fig. 2);

said match filter uses a lowpass filter (Section II and fig. 2); and

the reconstruction of a consistent signal (which yields the same measurements as the original signal) as long as there are as many measurements (samples) as there are degrees of freedom in the signal (Section V, B). One of ordinary skill in the art at the time of the invention would recognize that since the rate of innovation is defined by the total degrees of freedom of the wanted signal it would be obvious to sample at a greater than or equal to the rate of innovation in order to reconstruct information of the original signal with minimum error. Therefore it would be obvious to one of ordinary skill in the art at the time of the invention to combine the spread spectrum communication sampling method of Affes with the sampling method disclosed by Unser in order to create an improved method and system for sampling and reconstructing the information from the original signal while minimizing errors in the reconstructed information.

With regards to claim 21, Affes in view of Unser teaches the limitations of claim 7.

Affes teaches said communication channel comprises an array of antennas (fig. 1: antennas 1 through M).

8. Claims 9-15, 18-19, 22-25, and 30 are rejected under 35 U.S.C. 103(a) as being unpatentable over Affes (US 2002/0051433) in view of Unser ("Sampling – 50 Years After Shannon", Proceedings of the IEEE, Vol. 88, No.4: pages 569-587, April 2000.), and further in view of Agee (US 2003/0123384).

With regards to claim 9, Affes in view of Unser teaches the limitations of claim 7.

Affes teaches said sent signal includes a plurality of training sequences (paragraphs 302-306) each encoded with a user specific coding sequence ( $s_k(t)$ ) (paragraphs 302-306) and transmitted by said users ( $k$ ) (paragraphs 302-306), said method further comprising the steps of:

retrieving the delays (paragraphs 178-186) and the amplitude attenuations (paragraph 114) induced by said communication channel on said sent signal (figs. 1-2, 5, and 9: signal  $X(t)$ ), corresponding to said received signal ( $y(t)$ ) and corresponding to each of said user specific coding sequence (fig. 5: elements 18, 19 and 20);

and the use of form of Multi-Carrier CDMA (paragraph 435: MC-CDMA).

Affes does not explicitly teach determining the a set of spectral values ( $Y[m]$ ) corresponding to said received signal ( $y(t)$ ) from said set of sampled values ( $y(nT_s)$ ), recovering spectral values ( $S_k[m]$ ) corresponding to each of said user specific coding

sequence ( $s_k(t)$ ), wherein the determined amplitude and delays were determined from spectral values of the signal and spectral values of the user specific coding sequence.

Agee teaches the use of Fast Fourier transform (FFT) before the despreading unit (figs. 8-9: element 236, 242, 266, and 272) computing a set of spectral values ( $Y[m]$ ) corresponding to said received signal ( $y(t)$ ) from said set of sampled values (fig. 7B and 8-9: ADC output, and front end);

recovering spectral values ( $S_k[m]$ ) corresponding to each of said user specific coding sequence (figs. 8-9: elements 242 and 272).

Therefore it would be obvious to one of ordinary skill in the art at the time of the invention to combine the CDMA-OFDM communication system of Affes with the CDMA-OFDM system of Agee in order to create an improved system and method with lower complexity by using simple equalization of linear channel distortion (paragraph 30).

With regards to claim 10, Affes in view of Unser in further view of Agee teaches the limitations of claim 9.

Affes teaches the step of retrieving said delays and said amplitude attenuations includes solving a series of one-dimensional estimation problems (paragraphs 55 and 230: wherein receiver only has one antenna), the size of each said one-dimensional estimation problem being equal to the number of said sampled values generated during one symbol duration (fig. 16: element 29: paragraph 21).

With regards to claim 11, Affes in view of Unser in further view of Agee teaches the limitations of claim 10.

Affes further teaches said series of one-dimensional equation systems (figs. 16 and 44: elements 59, 43, 47, 25, and 29-32) is derived from said received signal (fig. 44: element 18), each of said user specific coding sequence (fig. 44: element 19) and the value of the bits of said training sequences (fig. 44: elements 29-35).

Affes does not explicitly teach the spectral value of the received signal and said user specific coding.

Agee teaches the use of Fast Fourier transform (FFT) before the despreading unit (figs. 8-9: element 236, 242, 266, and 272) computing a set of spectral values ( $Y[m]$ ) corresponding to said received signal ( $y(t)$ ) from said set of sampled values (fig. 7B and 8-9: ADC output, and front end);

recovering spectral values ( $Sk[m]$ ) corresponding to each of said user specific coding sequence (figs. 8-9: elements 242 and 272).

Therefore it would be obvious to one of ordinary skill in the art at the time of the invention to combine the CDMA-OFDM communication system of Affes with the CDMA-OFDM system of Agee in order to create an improved system and method with lower complexity by using simple equalization of linear channel distortion (paragraph 30).

With regards to claim 12, Affes in view of Unser in further view of Agee teaches the limitations of claim 11.

Affes further teaches decoding a second sent signal (figs. 1 and 16: element group 10, 14, and output to other receiver for other desired users) including a plurality of symbols (fig. 1 and 2: elements 13-16) each encoded with said user specific coding sequence ( $s_k(t)$ ) and transmitted by said users ( $k$ ), sampling said second sent signal ( $y(t)$ ) with a sampling frequency lower than the sampling frequency given by the Shannon theorem (paragraph 119).

Affes does not explicitly teach the sampling rate is greater than the rate of innovation ( $\rho$ ) of said received signal ( $y(t)$ ).

Unser teaches the reconstruction of a consistent signal (which yields the same measurements as the original signal) as long as there are as many measurements (samples) as there are degrees of freedom in the signal (Section V, B). One of ordinary skill in the art at the time of the invention would recognize that since the rate of innovation is defined by the total degrees of freedom of the wanted signal it would be obvious to sample at a greater than or equal to the rate of innovation in order to reconstruct information of the original signal with minimum error. Therefore it would be obvious to one of ordinary skill in the art at the time of the invention to combine the spread spectrum communication sampling method of Affes with the sampling method disclosed by Unser in order to create an improved method and system for sampling and reconstructing the information from the original signal while minimizing errors in the reconstructed information.

With regards to claim 13, Affes in view of Unser in further view of Agee teaches the limitations of claim 12.

Affes further teaches running a multiuser detection scheme using said second set of sampled values (fig. 16: output of element 18: to receiver for other desired users: note that the decoding process for each user is repeated) and previously computed said delays (paragraphs 178-186) and said amplitude attenuations (paragraph 114) for estimating the value of the symbol ( $b_k$ ) sent by each said user (fig. 16: elements 29: paragraph 21).

With regards to claim 14, Affes in view of Unser in further view of Agee teaches the limitations of claim 13.

Affes further teaches said multiuser detection scheme (fig. 16: output of element 18: to receiver for other desired users: note that the decoding process for each user is repeated) is a decorrelating detection scheme (paragraph 7).

With regards to claims 15 and 18, Affes in view of Unser in further view of Agee teaches the limitations of claim 12.

Affes further teaches said multiuser detection scheme (fig. 16: output of element 18: to receiver for other desired users: note that the decoding process for each user is repeated) is a minimum mean-square error detection scheme (paragraph 8).

With regards to claim 19, Affes in view of Unser teaches the limitations of claim 7.



Affes teaches said sent signal includes a plurality of training sequences (paragraphs 302-306) each encoded with a user specific coding sequence ( $sk(t)$ ) (paragraphs 302-306) and transmitted by said users ( $k$ ) (paragraphs 302-306), said method further comprising the steps of:

computing a set sampled values from said received signal (fig. 16: output of element 18).

computing a set of channel dependant values (figs. 1-2, 5, and 9: signal  $X(t)$ : paragraphs 114 and 178-186) from the sampled signal (fig. 44: output of element 18) and said training sequences (fig. 44: paragraphs 302-306).

decoding a second sent signal (figs. 1 and 16: element group 10, 14, and output to other receiver for other desired users) including a plurality of symbols (fig. 1 and 2: elements 13-16) each encoded with said user specific coding sequence ( $sk(t)$ ) and transmitted by said users ( $k$ ), sampling said second sent signal ( $y(t)$ ) with a sampling frequency lower than the sampling frequency given by the Shannon theorem (paragraph 119).

retrieving the value of the symbol (figs. 16 and 44: elements 28-30, 47, 43, 29-35) by each said user by solving a linear matrix system (figs. 16 and 44: elements 28-30, 47, 43, 29-35) including said second set of sampled values (figs. 16 and 44: output of element 18: "to receivers for other desired users": note that the recovery process is repeated for each desired user) and said set of channel dependant values (elements 28-30, 47, 43, 29-35)).

Affes does not explicitly teach two Limitations: Limitation 1) Affes does not explicitly teach the sampling rate is greater than the rate of innovation ( $\rho$ ) of said received signal ( $y(t)$ ); Limitation 2) determining the a set of spectral values ( $Y[m]$ ) corresponding to said received signal ( $y(t)$ ) from said set of sampled values ( $y(nT_s)$ ), wherein the determined channel values were determined from spectral values of the signal and spectral values of the user specific coding sequence.

*Limitation 1)*

Affes does not explicitly teach the sampling rate is greater than the rate of innovation ( $\rho$ ) of said received signal ( $y(t)$ ).

Unser teaches the reconstruction of a consistent signal (which yields the same measurements as the original signal) as long as there are as many measurements (samples) as there are degrees of freedom in the signal (Section V, B). One of ordinary skill in the art at the time of the invention would recognize that since the rate of innovation is defined by the total degrees of freedom of the wanted signal it would be obvious to sample at a greater than or equal to the rate of innovation in order to reconstruct information of the original signal with minimum error. Therefore it would be obvious to one of ordinary skill in the art at the time of the invention to combine the spread spectrum communication sampling method of Affes with the sampling method disclosed by Unser in order to create an improved method and system for sampling and reconstructing the information from the original signal while minimizing errors in the reconstructed information.

*Limitation 2)*

Affes does not explicitly teach determining the a set of spectral values ( $Y[m]$ ) corresponding to said received signal ( $y(t)$ ) from said set of sampled values ( $y(nT_s)$ ), wherein the determined channel values were determined from spectral values of the signal and spectral values of the user specific coding sequence.

Agee teaches the use of Fast Fourier transform (FFT) before the dispreading unit (figs. 8-9: element 236, 242, 266, and 272) computing a set of spectral values ( $Y[m]$ ) corresponding to said received signal ( $y(t)$ ) from said set of sampled values (fig. 7B and 8-9: ADC output, and front end);

recovering spectral values ( $Sk[m]$ ) corresponding to each of said user specific coding sequence (figs. 8-9: elements 242 and 272).

Therefore it would be obvious to one of ordinary skill in the art at the time of the invention to combine the CDMA-OFDM communication system of Affes with the CDMA-OFDM system of Agee in order to create an improved system and method with lower complexity by using simple equalization of linear channel distortion (Agee: paragraph 30).

With regards to claim 22, Affes in view of Onser teaches the limitations of claim 21.

Affes teaches said sent signal includes a plurality of training sequences (paragraphs 302-306) each encoded with a user specific coding sequence ( $sk(t)$ ), (paragraphs 302-306) and transmitted by said users ( $k$ ) (paragraphs 302-306), said method further comprising the steps of:

sampling the received signal ( $y(t)$ ) from each antenna (figs. 1 and 16: elements 11-12 and 18-19) with a sampling frequency ( $f_s$ ) lower than the sampling frequency given by the Shannon theorem (paragraph 119) for generating a set of sampled values (fig. 9: output of element 18).

retrieving the delays (paragraphs 178-186) and the amplitude attenuations (paragraph 114) and direction of arrival ( $\theta$ ) induced by said communication channel on said sent signal (figs. 1-2, 5, and 9: signal  $X(t)$ ), corresponding to said received signal ( $y(t)$ ) and corresponding to each of said user specific coding sequence (fig. 5: elements 18, 19 and 20);

and the use of form of Multi-Carrier CDMA (paragraph 435: MC-CDMA).

Affes does not explicitly determining the a set of spectral values ( $Y[m]$ ) corresponding to said received signal ( $y(t)$ ) from said set of sampled values ( $y(nT_s)$ ), recovering spectral values ( $S_k[m]$ ) corresponding to each of said user specific coding sequence ( $s_k(t)$ ), wherein the determined amplitude and delays were determined from spectral values of the signal and spectral values of the user specific coding sequence; and determining the direction of arrival of the received signal.

Agee teaches the use of Fast Fourier transform (FFT) before the dispreading unit (figs. 8-9: element 236, 242, 266, and 272) computing a set of spectral values ( $Y[m]$ ) corresponding to said received signal ( $y(t)$ ) from said set of sampled values (fig. 7B and 8-9: ADC output, and front end);

recovering spectral values ( $S_k[m]$ ) corresponding to each of said user specific coding sequence (figs. 8-9: elements 242 and 272).

determining the direction of arrival of the received signal (paragraphs 127-130).

Therefore it would be obvious to one of ordinary skill in the art at the time of the invention to combine the CDMA-OFDM communication system of Affes with the CDMA-OFDM system of Agee in order to create an improved system and method with lower complexity by using simple equalization of linear channel distortion (Agee: paragraph 30).

With regards to claim 23, Affes in view of Onser in further view of Agee teaches the limitations of claim 22.

Affes teaches the step of retrieving said delays and said amplitude attenuations and directions of arrival includes solving a series of two-dimensional estimation problems (paragraphs 55 and 230: wherein receiver combines the signal from two antennas), the size of each said two-dimensional estimation problem being equal to the number of said sampled values generated during one symbol duration (fig. 16: element 29: paragraph 21).

With regards to claim 24, Affes in view of Onser in further view of Agee teaches the limitations of claim 23.

Affes teaches said sent signal includes a plurality of training sequences (paragraphs 302-306) each encoded with a user specific coding sequence ( $s_k(t)$ ) (paragraphs 302-306) and transmitted by said users ( $k$ ) (paragraphs 302-306), said method further comprising the steps of:

sampling the received signal ( $y(t)$ ) from each antenna (figs. 1 and 16: elements 11-12 and 18-19) with a sampling frequency ( $f_s$ ) lower than the sampling frequency given by the Shannon theorem (paragraph 119) for generating a set of sampled values (fig. 9: output of element 18).

retrieving the delays (paragraphs 178-186) and the amplitude attenuations (paragraph 114) and direction of arrival induced by said communication channel on said sent signal (figs. 1-2, 5, and 9: signal  $X(t)$ ), corresponding to said received signal ( $y(t)$ ) and corresponding to each of said user specific coding sequence (fig. 5: elements 18, 19 and 20);

and the use of form of Multi-Carrier CDMA (paragraph 435: MC-CDMA).

Affes does not explicitly determining the a set of spectral values ( $Y[m]$ ) corresponding to said received signal ( $y(t)$ ) from said set of sampled values ( $y(nT_s)$ ), recovering spectral values ( $Sk[m]$ ) corresponding to each of said user specific coding sequence ( $sk(t)$ ), wherein the determined amplitude and delays were determined from spectral values of the signal and spectral values of the user specific coding sequence; and determining the direction of arrival of the received signal.

Agee teaches the use of Fast Fourier transform (FFT) before the dispreading unit (figs. 8-9: element 236, 242, 266, and 272) computing a set of spectral values ( $Y[m]$ ) corresponding to said received signal ( $y(t)$ ) from said set of sampled values (fig. 7B and 8-9: ADC output, and front end);

recovering spectral values ( $Sk[m]$ ) corresponding to each of said user specific coding sequence (figs. 8-9: elements 242 and 272).

determining the direction of arrival of the received signal (paragraphs 127-130).

Therefore it would be obvious to one of ordinary skill in the art at the time of the invention to combine the CDMA-OFDM communication system of Affes with the CDMA-OFDM system of Agee in order to create an improved system and method with lower complexity by using simple equalization of linear channel distortion (Agee: paragraph 30).

With regards to claim 25, Affes in view of Onser in further view of Agee teaches the limitations of claim 24.

decoding a second sent signal (figs. 1 and 16: element group 10, 14, and output to other receiver for other desired users) including a plurality of symbols (fig. 1 and 2: elements 13-16) each encoded with said user specific coding sequence ( $sk(t)$ ) and transmitted by said users ( $k$ ), sampling said second sent signal and first sent signal with a sampling frequency lower than the sampling frequency given by the Shannon theorem (paragraph 119).

Affes does not explicitly teach orienting the beams of said array of antennas (i) towards previously determined said arrival directions.

Agee teaches orienting the beams of said array of antennas (i) towards previously determined said arrival directions (paragraphs 127-135).

Therefore it would be obvious to one of ordinary skill in the art at the time of the invention to combine the CDMA-OFDM communication system of Affes with the CDMA-OFDM system of Agee in order to create an improved system and method with lower

complexity by using simple equalization of linear channel distortion (Agee: paragraph 30).

With regards to claim 30, Affes in view of Unser teaches the limitations of claim 29.

Affes teaches comprising a memory for storing said signature sequences (fig. 16: elements 18-19: wherein the de-spreaders would inherently store the signature sequences in memory).

Affes does not explicitly teach having said spectral values of said signature sequences.

Agee teaches the use of Fast Fourier transform (FFT) before the despreading unit (figs. 8-9: element 236, 242, 266, and 272) computing a set of spectral values ( $Y[m]$ ) corresponding to said received signal ( $y(t)$ ) from said set of sampled values (fig. 7B and 8-9: ADC output, and front end);

Therefore it would be obvious to one of ordinary skill in the art at the time of the invention to combine the CDMA-OFDM communication system of Affes with the CDMA-OFDM system of Agee in order to create an improved system and method with lower complexity by using simple equalization of linear channel distortion (paragraph 30).

9. Claim 26 is rejected under 35 U.S.C. 103(a) as being unpatentable over Affes (US 2002/0051433) in view of Unser ("Sampling – 50 Years After Shannon", Proceedings of the IEEE, Vol. 88, No.4: pages 569-587, April 2000.), and further in view of Agee (US 2003/0123384) with Huang (USPN 6,370,129).



With regards to claim 26, Affes in view of Onser in further view of Agee teaches the limitations of claim 25.

Affes further teaches running a detection scheme using said second set of sampled values (fig. 16: output of element 18: to receiver for other desired users: note that the decoding process for each user is repeated) and previously computed said delays (paragraphs 178-186) and said amplitude attenuations (paragraph 114) for estimating the value of the symbol ( $b_k$ ) sent by each said user (fig. 16: elements 29: paragraph 21).

Affes does not explicitly teach running a 2D-RAKE.

Huang teaches using a 2D-Rake (col. 6, lines 3-25).

Therefore it would be obvious to one of ordinary skill in the art at the time of the invention to combine the CDMA-OFDM multi-user communication system of Affes with the CDMA multi-user communication system of Huang in order to implement an improved multi-user detection scheme which mitigates multi-user interference in a high speed mixed traffic environment (col. 2, line 1-5 and col. 5, line 62 through col. 6, line 25).

10. Claim 27 is rejected under 35 U.S.C. 103(a) as being unpatentable over Affes (US 2002/0051433) in view of Unser ("Sampling – 50 Years After Shannon", Proceedings of the IEEE, Vol. 88, No.4: pages 569-587, April 2000.) as applied to claim 1 above, and further in view of Shattil (USPN 7,076,168).

With regards to claim 27, Affes teaches a method for decoding a signal ( $y(t)$ ) sent over a bandwidth-expanding communication channel (paragraphs 14-23), comprising the step of sampling the received signal ( $y(t)$ ) with a sampling frequency ( $f_s$ ) lower than the sampling frequency given by the Shannon theorem (paragraph 119) for generating a set of sampled values (fig. 9: output of element 18).

Affes does not explicitly teach two Limitations: Limitation 1) the sampling rate is greater than the rate of innovation ( $\rho$ ) of said received signal ( $y(t)$ ); and Limitation 2) said bandwidth-expanding communication channel is an Ultra Wideband (UWB) communication system.

Limitation 1)

Unser teaches the reconstruction of a consistent signal (which yields the same measurements as the original signal) as long as there are as many measurements (samples) as there are degrees of freedom in the signal (Section V, B). One of ordinary skill in the art at the time of the invention would recognize that since the rate of innovation is defined by the total degrees of freedom of the wanted signal it would be obvious to sample at a greater than or equal to the rate of innovation in order to reconstruct information of the original signal with minimum error. Therefore it would be obvious to one of ordinary skill in the art at the time of the invention to combine the spread spectrum communication sampling method of Affes with the sampling method disclosed by Unser in order to create an improved method and system for sampling and

reconstructing the information from the original signal while minimizing errors in the reconstructed information.

Limitation 2)

Shattil teaches said bandwidth-expanding communication channel is an Ultra Wideband (UWB) communication system (col. 17, lines 1-10 and col. 19, lines 15-32).

Therefore it would have been obvious to one of ordinary skill in the art to modify the CDMA method of Affes with the multi-carrier CDMA method of Shattil in order to create an improved CDMA transmission method capable of high speed transmission and increased throughput with lower complexity that does not use high-speed processing (Shattil: col. 16, line 65 through col. 17, line 9).

11. Claim 28 is rejected under 35 U.S.C. 103(a) as being unpatentable over Affes (US 2002/0051433) in view of Unser ("Sampling – 50 Years After Shannon", Proceedings of the IEEE, Vol. 88, No.4: pages 569-587, April 2000.), and further in view of Langberg (USPN 5,852,630).

With regards to claim 28, Affes teaches a method for decoding a signal ( $y(t)$ ) sent over a bandwidth-expanding communication channel (paragraphs 14-23), comprising the step of sampling the received signal ( $y(t)$ ) with a sampling frequency ( $f_s$ ) lower than the sampling frequency given by the Shannon theorem (paragraph 119) for generating a set of sampled values (fig. 9: output of element 18).

Affes does not explicitly teach two Limitations: Limitation 1) the sampling rate is

greater than the rate of innovation ( $\rho$ ) of said received signal ( $y(t)$ ); and Limitation 2) a computer program directly loadable into the internal memory of a digital processing system and comprising software code portions for performing the method of claim 1 when said product is run by said digital processing system

Limitation 1)

Unser teaches the reconstruction of a consistent signal (which yields the same measurements as the original signal) as long as there are as many measurements (samples) as there are degrees of freedom in the signal (Section V, B). One of ordinary skill in the art at the time of the invention would recognize that since the rate of innovation is defined by the total degrees of freedom of the wanted signal it would be obvious to sample at a greater than or equal to the rate of innovation in order to reconstruct information of the original signal with minimum error. Therefore it would be obvious to one of ordinary skill in the art at the time of the invention to combine the spread spectrum communication sampling method of Affes with the sampling method disclosed by Unser in order to create an improved method and system for sampling and reconstructing the information from the original signal while minimizing errors in the reconstructed information.

Limitation 2)

Affes in view of Unser teaches all of the subject matter as described above except for the method written by a software program loadable into the internal memory of the digital processing system, said program embodied in a computer-readable medium.

Langberg et al. teaches that the method and apparatus for a transceiver warm start activation procedure with pre-coding can be implemented in software stored in a computer-readable medium. The computer-readable medium is an electronic, magnetic, optical, or other physical device or means that can contain or store a computer program for use by or in connection with a computer-related system or method (col. 3, lines 51-65). One skilled in the art would have clearly recognized that the method of Affes in view of Unser would have been implemented in software. The implemented software would perform the same function of the hardware for less expense, and have increased adaptability, and flexibility. Therefore, it would have been obvious to one of ordinary skill in the art at the time of the invention to use the software as taught by Langberg et al. in the method of Affes in view of Unser in order to reduce cost and improve the adaptability and flexibility of the communication system.

12. Claims 31-33 are rejected under 35 U.S.C. 103(a) as being unpatentable over Affes (US 2002/0051433) in view of Unser ("Sampling – 50 Years After Shannon", Proceedings of the IEEE, Vol. 88, No.4: pages 569-587, April 2000.), and further in view of Agee (US 2003/0123384) with Baum (USPN 7,218,666).

With regards to claim 31, Affes in view of Unser in further view of Agee teaches the limitations of claim 30.

Affes teaches a set of at least two encoders (figs. 16 and 44: elements 18-19, 27-30, and 35), each encoder of said set of encoders being assigned at least one training

sequence (fig. 44: elements 18, 28-32, and 35) to be sent over a bandwidth-expanding channel during a training phase (paragraphs 302-306),

Affes does not explicitly teach the at least one training sequence (paragraphs 302-306) is chosen such that it is linearly independent from any other training sequence (paragraphs 302-306) assigned to any other encoder (paragraphs 302-306) of said set of encoders.

Baum teaches the at least one training sequence (col. 12, line 40 through col. 13, line 7) is chosen such that it is linearly independent from any other training sequence (col. 12, line 40 through col. 13, line 7) assigned to any other encoder (col. 12, line 40 through col. 13, line 7) of said set of encoders.

Therefore it would be obvious to one of ordinary skill in the art at the time of the invention to modify the CDMA-OFDM communication system of Affes with the pilot chip symbols of Baum in order to create an improved system capable of more actually measuring the frequency response of the channel with less interference from other user signals.

With regards to claim 32, Affes in view of Unser in further view of Agee with Baum teaches the limitations of claim 31.

Affes teaches a set of at least two encoders, each said encoder (50) being assigned at least one said training sequences (bkt), wherein each said encoder (50) is designed to select from said at least one training sequences (bkt) the training sequence (bkt) to be sent during said training phase (30).

Affes does not explicitly teach assigned at least two said training sequences (bkt), and said encoder is designed to select from said at least two training sequences.

Baum teaches assigned at least two said training sequences, and said encoder is designed to select from said at least two training sequences (col. 12, line 40 through col. 13, line 7).

Therefore it would be obvious to one of ordinary skill in the art at the time of the invention to modify the CDMA-OFDM communication system of Affes with the pilot chip symbols of Baum in order to create an improved system capable of more actually measuring the frequency response of the channel with less interference from other user signals.

With regards to claim 33, Affes in view of Unser in further view of Agee with Baum teaches the limitations of claim 32.

Affes teaches each of two said encoder being assigned a specific coding sequence (fig. 2: elements b.sub.n and 13: paragraphs 302-306) for coding a signal to be sent over said bandwidth-expanding channel (fig. 2: elements b.sub.n and 13: paragraphs 302-306), wherein said coding sequence ( $sk(t)$ ) is chosen such that, when filtered, for estimating the value of the symbol (bk) sent by each said user (fig. 16: elements 19, 42, 29-30).

Affes does not explicitly teach said filter being a lowpass filter such that the signal is filtered with a lowpass filter (f), it is orthogonal to any specific coding sequence ( $sk(t)$ )

assigned to any other encoder (50) of said set of encoders filtered with said lowpass filter (f).

Unser teaches that when lowpass filtered, the signal is orthogonal to any other user's specific coding sequence ( $s_k(t)$ ) used in said communication channel (Section II and fig. 2);

said match filter uses a lowpass filter (Section II and fig. 2); and

the reconstruction of a consistent signal (which yields the same measurements as the original signal) as long as there are as many measurements (samples) as there are degrees of freedom in the signal (Section V, B). One of ordinary skill in the art at the time of the invention would recognize that since the rate of innovation is defined by the total degrees of freedom of the wanted signal it would be obvious to sample at a greater than or equal to the rate of innovation in order to reconstruct information of the original signal with minimum error. Therefore it would be obvious to one of ordinary skill in the art at the time of the invention to combine the spread spectrum communication sampling method of Affes with the sampling method disclosed by Unser in order to create an improved method and system for sampling and reconstructing the information from the original signal while minimizing errors in the reconstructed information.

### ***Conclusion***

Any inquiry concerning this communication or earlier communications from the examiner should be directed to James M. Perez whose telephone number is 571-270-



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3231. The examiner can normally be reached on Monday through Friday: 9am to 5pm EST.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Shuwang Liu can be reached on 571-272-3036. The fax phone number for the organization where this application or proceeding is assigned is 571-273-8300.

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